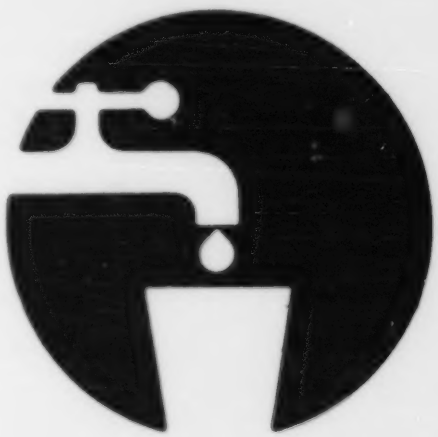
Strategic Planning Branch **REPORT**

Know Your City

A Water Consumption Model for the City of Edmonton: An Update

Research Paper No. 31



June, 1989

The City of Edmonton Planning and Development

RESEARCH PAPER NO. 31

A Water Consumption Model for the City of Edmonton: An Update

by

Patrick Walters and Jong Huang

Prepared for Edmonton Environmental Services Department

92-01563/

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Important Note: This technical paper was prepared by the Forecasting and Policy Development Group, Strategic Planning Branch, Planning and Development Department. It documents research results as part of an ongoing forecasting activity. Neither the methods nor the results have been endorsed by the City of Edmonton.

JUNE 1989

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EXECUTIVE SUMMARY

1. Purpose

The purposes of this report are to:

(i) identify factors that influence water consumption in Edmonton;
(ii) estimate the statistical relationship between annual water consumption and the factors identified above;
(iii) forecast water consumption over the next five years based on the model; and
(iv) undertake a sensitivity analysis of water rate increases.

This report and model were prepared in response to a request from the Edmonton Environmental Services Department to update their current water forecasting model.

The market for water is divided into three groups: domestic, commercial and industrial.

2. Empirical Results

Econometric methods were used to estimate equations for the number of customers and average consumption.

2.1 Domestic Consumption

. The average annual consumption per domestic customer is affected by the average of the April to September temperature, the domestic water rate, the interest rate and the percentage increase in the day time housekeepers.

. The number of domestic customers is influenced by the Edmonton CMA's population and the general level of Alberta's economic activity as measured by the gross domestic product.

2.2 Commercial Consumption

. Average commercial ccnsumption is explained by the commercial water rate, the rate of interest and the Edmonton CMA's population growth rate.

. The number of commercial customers is determined by the Edmonton CMA's employment growth rate and the Edmonton CMA's population.

2.3 Industrial Consumption

. The average annual consumption for industrial usage is determined by the industrial water rate, the growth rate of the gross provincial product and Edmonton CMA's employment.

. The number of industrial and commercial customers is explained by the Edmonton CMA's employment growth rate and the Edmonton CMA's population.

3. Forecast

. Total annual water consumption is forecasted to increase from 93 million cubic meters in 1988 to 107 million cubic meters in 1994.

. The total domestic customers are projected to climb from 148,000 households in 1988 to 169,000 households by 1994.

. The total of industrial and commercial customers are forecasted to grow from 16,884 units in 1988 to 18,371 units in 1994.

4. Rate Analysis

. The computed elasticities for the three groups of water consumers are all less than one, indicating that water demand is inelastic in response to water rate changes.

1. INTRODUCTION

1.1 Purposes

The purposes of this report are to: (1) identify factors that influence water consumption in Edmonton; (2) estimate the statistical relationship between annual water consumption and the factors identified above; (3) forecast water consumption over the next five years based on the model; and (4) undertake a sensitivity analysis of water rate increases.

This report and model were prepared in response to a request from the Edmonton Environmental Services Department to update their current water forecasting model. This request is in keeping with the suggestions of a 1987 report (Hussey and Huang 1987):

> It is, . . . recommended that the water consumption model be updated and refined on a regular basis to incorporate new data and to reflect current trends in consumption that may be due to structural shifts in socio-economic indicators.

1.2 Background

The City of Edmonton Environmental Services Department provides water for in-city and suburban purposes. In-city consumption is defined as the volume of water consumed by people and businesses resident within Edmonton; suburban consumption is water consumed by people residing within the Edmonton region outside of the City of Edmonton (e.g., St. Albert, Leduc, Vegreville). This report deals with in-city consumption only. In-city consumption is further divided into domestic, commercial and industrial uses.

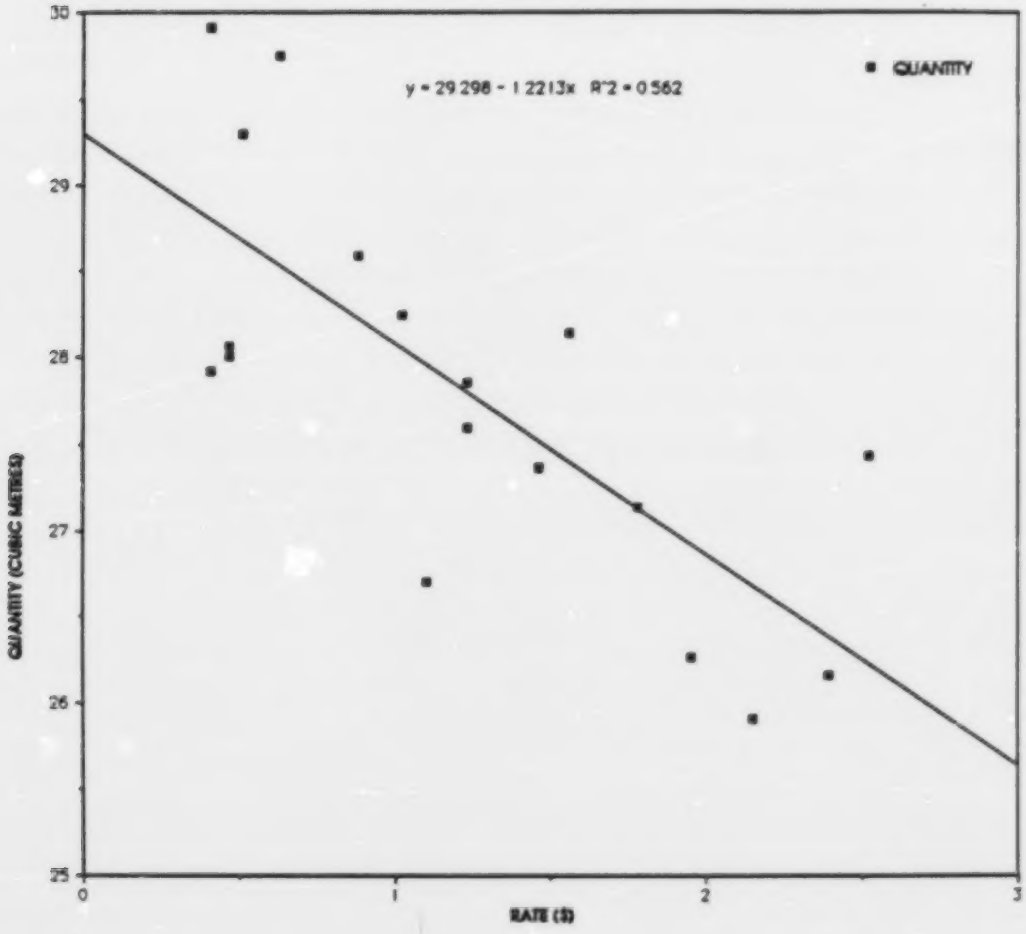
Total water consumption in 1988 for Edmonton was 93.2 million cubic meters: domestic consumption accounted for 43.7% of the

total while industrial consumption was 12.9% and commercial 43.4%. The total consumption in 1988 represented a 39.3% increase over total consumption in 1973 or 2.6% average growth per year.

1.3 Organization of the Report

The report is divided into 5 sections. Section 1 is devoted to a description of the project and its objectives. In Section 2 a set of hypotheses are presented regarding the expected relationships between water consumption and the various factors. The estimated equations which quantify the relationships are presented in Section 3. In addition, the equations are tested to see how well they estimated the 1976 - 1988 period. A forecast for the period 1989 - 1994 is discussed in Section 4. The final section contains a discussion on potential implications and conclusions.

FIGURE 1
WATER RATE AND AVERAGE CONSUMPTION - DOMESTIC



2. HYPOTHESES

The purpose of the model is to explore the relationship between In-city water consumption in urban Edmonton and a series of factors which explain changes in consumer behaviour. The explanatory variables that have been identified are based on conclusions drawn from discussions with Edmonton Environmental Services officials (Huang and Hussey 1987) and from the theoretical literature on consumer behaviour (Green 1971, Johnson 1971).

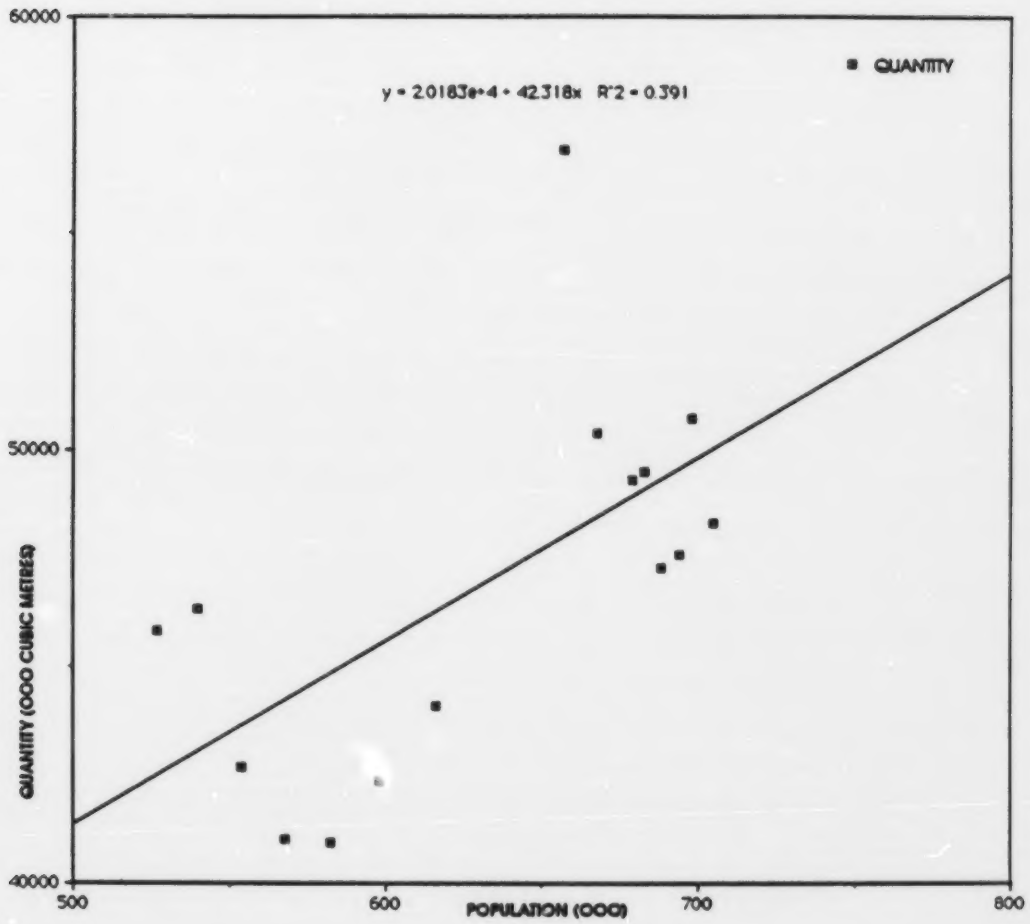
The market for potable water is segmented into three groups by Edmonton Environmental Services: domestic, commercial and industrial. Domestic customers are single family or semi-detached residential consumers whose usage of water is measured by individual water meters. Commercial includes both business and multi-family residential consumption. The term "commercial" is a misnomer since manufacturing firms are also included in this category. The distinguishing feature between commercial and other groups is that the customer uses less than 14,158 cubic meters of water per month and the customer is non-domestic. Finally, industrial customers are users who consume more than 14,158 cubic meters of water per month.

The following are the propositions related to each plausible explanatory variable of water consumption:

(i) Water Rates

Water is regarded as a scarce resource by the City and, as a result, a price is charged for its use. The expected relationship between water rates and usage is assumed to be negative. An increase in the water rate is expected to produce a reduction in the quantity of water used (see Figure 1).

FIGURE 2
AVERAGE CONSUMPTION AND POPULATION - INDUSTRIAL



(ii) Population

The population variable in the model refers to the Edmonton Census Metropolitan Area. Metro data was used because of the discontinuity created by annexations in the City and because of the strong commercial and industrial linkages between Edmonton and the rest of the region.

Population is assumed to have a positive relationship with the number of customers. An increase in the population is expected to result in an increase in the number of customers. (see Figure 2).

(iii) Employment

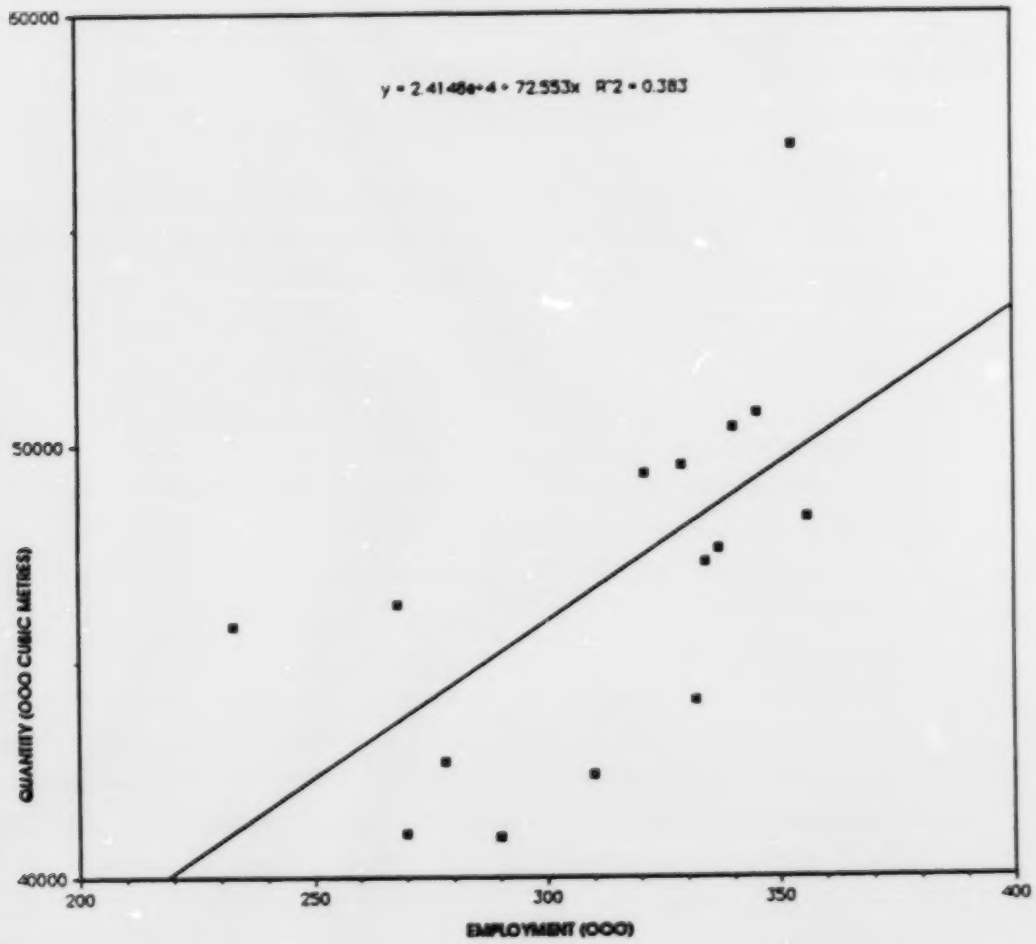
Employment figures used in the model are for the Edmonton C.M.A. The reasons for using this data as opposed to that for the City proper are similar to those for population. In addition, time series data on employment is not readily available for the City proper.

Employment is used as a measure of economic activity in the Edmonton C.M.A. As a result, the expected relationship between employment and average industrial consumption and the number of commercial and industrial customers are expected to be positive. An increase in employment is expected to induce an increase in the number of commercial and industrial customers. Similarly, an increase in the level of employment would result in an increase in the average quantity consumed (see Figure 3).

(iv) Day-Time Housekeepers

The day-time housekeepers include those individuals who are unemployed and those aged fifteen years and over but not in the

FIGURE 3
AVERAGE CONSUMPTION AND EMPLOYMENT - INDUSTRIAL



labour force. This variable is used to estimate the population that is present in homes during the working day.

The expected relationship between the day-time housekeepers and the average domestic consumption is assumed to be positive. As a result, an increase in the day-time housekeepers is expected to bring about a rise in average domestic consumption. This result is not unusual since the larger the day-time housekeepers the greater is the opportunity for it to use water.

(v) Economic Growth

The economic growth indicator is used to represent two different relationships: the number of domestic consumers and average industrial consumption. Gross Domestic Product for Alberta (GDPA) is assumed to be an important determinant of the number of residential customers given past historical trends of migration and population growth. As a result, the estimated relationship between GDPA and the number of residential customers is expected to be positive. A negative correlation is anticipated between economic growth and average industrial consumption since marginal firms are expected to enter the industrial class during rapid expansion which serve to depress average consumption. In an economic slowdown the reverse is expected to occur as marginal firms fall from the industrial class thus causing the average consumption per industrial user to increase.

(vi) Meteorological Activity

Domestic water consumption is strongly influenced by weather conditions. The correlation between the average April to September temperature and average domestic consumption is expected to be positive.

(vii) Interest Rate

The interest rate is used to represent the cost of borrowing and the return on savings. As the interest rate increases the cost of borrowing becomes more expensive and at the same time savings becomes much more attractive. Customers are therefore expected to reduce the quantity demanded of a product in response to an increase in the rate of interest. The estimated sign on the regression coefficient between average consumption and interest rate is expected to be negative.

FIGURE 4A
AVERAGE DOMESTIC CONSUMPTION

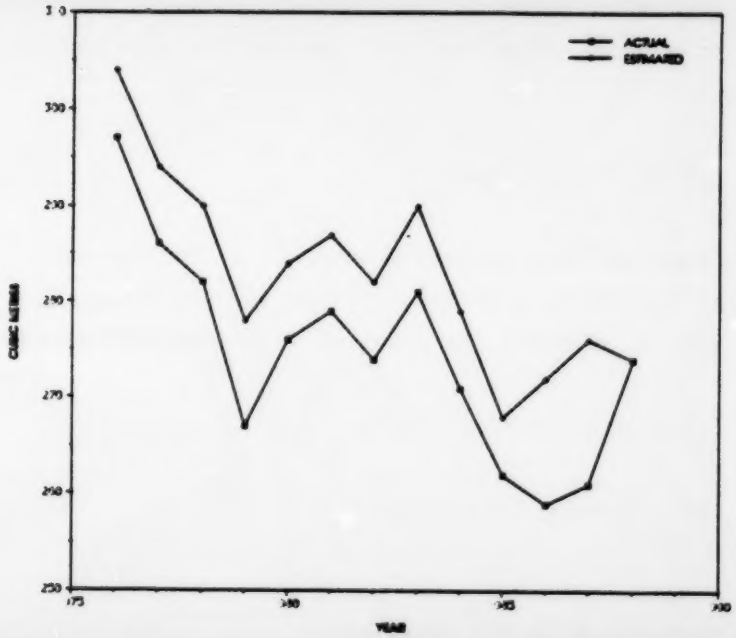
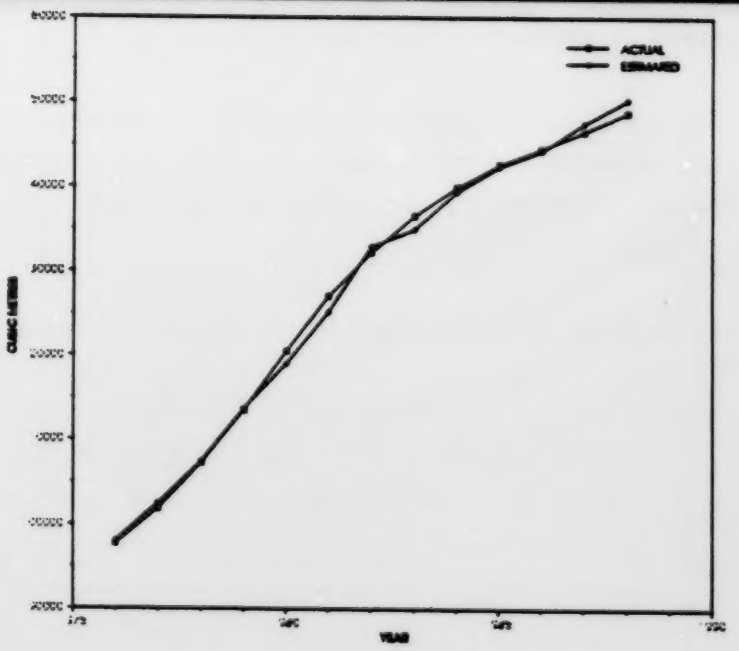


FIGURE 4B
DOMESTIC CUSTOMERS



3. EMPIRICAL RESULTS

This section presents the estimated equations and related statistics. In addition, the equations are simulated to show how well they estimate the period 1976 - 1988 using the 1971-1988 data.

3.1 Estimated Equations

Equations were estimated separately for domestic, commercial and industrial consumption. In addition, an aggregate equation was used to estimate the total of commercial and industrial customers.

3.1.1 Domestic Consumption

(a) Average Consumption

Annual average consumption per domestic customer (ACDC) is represented by the equation:

$$ACDC = a_0 + a_1\ AVETEMP + a_2\ IR + a_3\ WRDC + a_4\ DPOPR$$

where $a_1 > 0$, $a_2 < 0$, $a_3 < 0$ and $a_4 > 0$

AVETEMP refers to the average Edmonton temperature between April and September, WRDC is the water rate for domestic customers and DPOPR represents the percent increase in the day-time housekeepers.

Estimating the above equation yields the following results:

$$ACDC = 171.4 + 10.1AVETEMP - 0.8IR - 37.91WRDC + 0.6DPOPR$$
$$(6.11)\ (4.47) \qquad (2.16)\ (6.83)\ (2.39)$$
$$R^2 = .84 \qquad R^{-2} = .79 \qquad DW = 1.89 \qquad SEE = 5.25$$

FIGURE 4C
AVERAGE COMMERCIAL CONSUMPTION

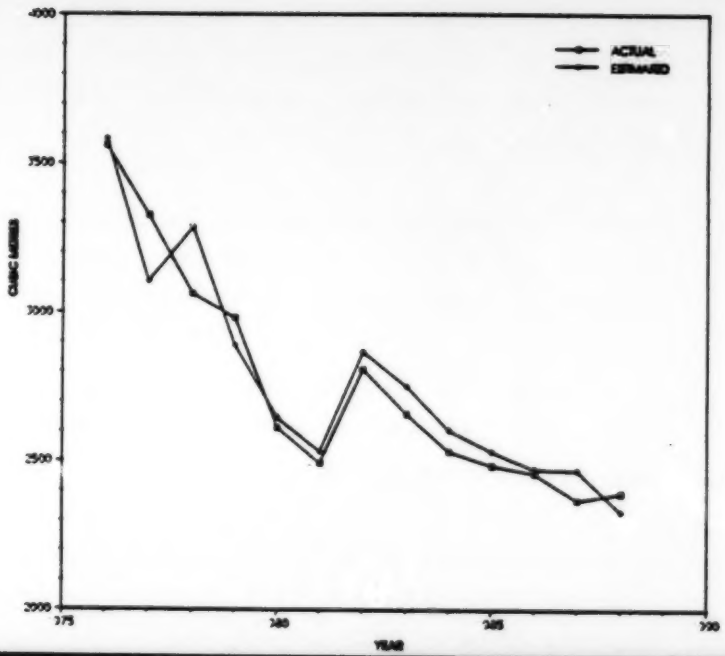
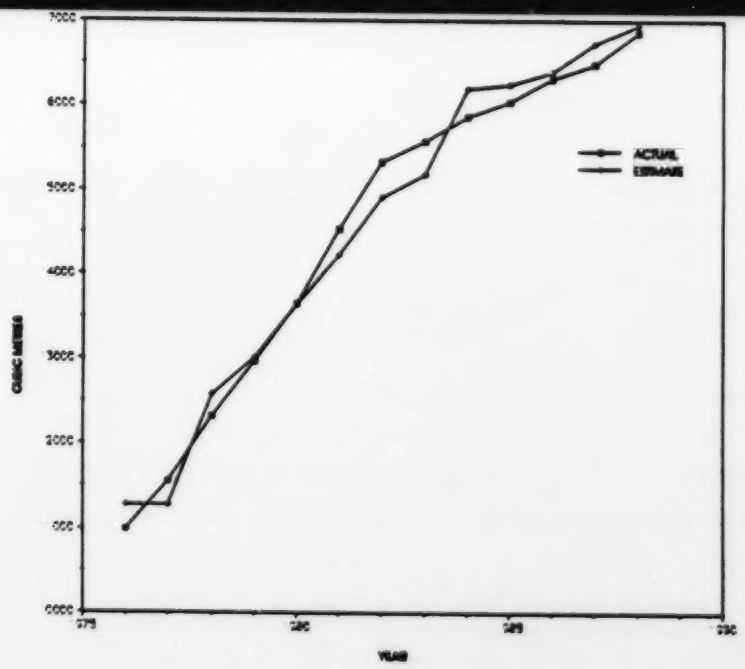


FIGURE 4D
COMMERCIAL CUSTOMERS



The equation states that:

- every 1^{o} C increase in mean temperature for the six months from April to September inclusive will result in a 10.1 cubic meter increase in average consumption per domestic customer per year;

- a 1% increase in the rate of interest would produce a decline of 0.8 cubic meters in the average consumption per domestic customer per year;

- a 1% increase in the day-time housekeepers can be expected to increase average consumption per domestic customer per year by 0.6 cubic meters; and

- a 1$ increase per cubic meter in the domestic water rate is expected to result in a 37.9 cubic meter reduction in the quantity of water demand.

The above variables together explain 84 percent of the variation in average domestic consumption.

(b) Number of Customers

The number of domestic customers (NDC) is estimated by the following equation:

$$NDC = L_0 + L_1 \text{ POPEL} + L_2 \text{ GDPA}$$

where $L_1 > 0$, $L_2 > 0$

POPEL refers to the Edmonton CMA population for the previous year and GDPA represents Alberta's gross domestic product.

FIGURE 5A
AVERAGE INDUSTRIAL CONSUMPTION

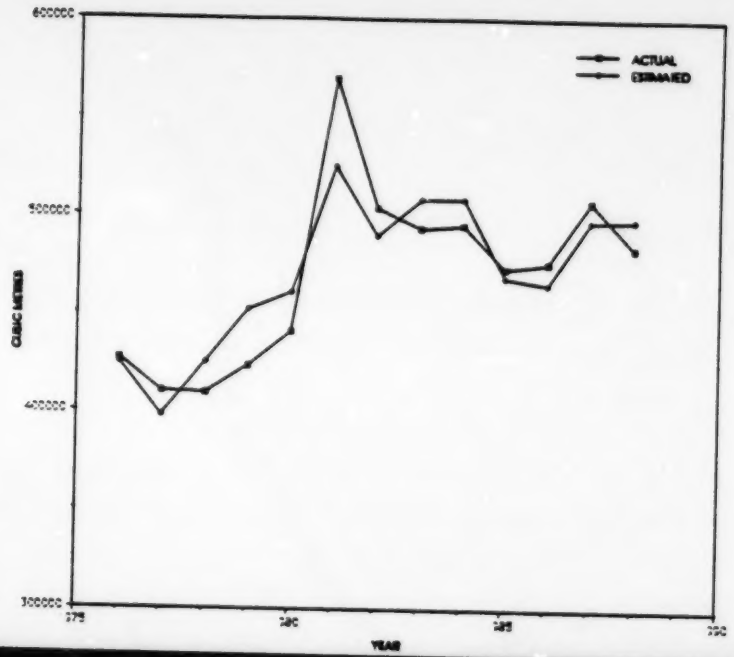
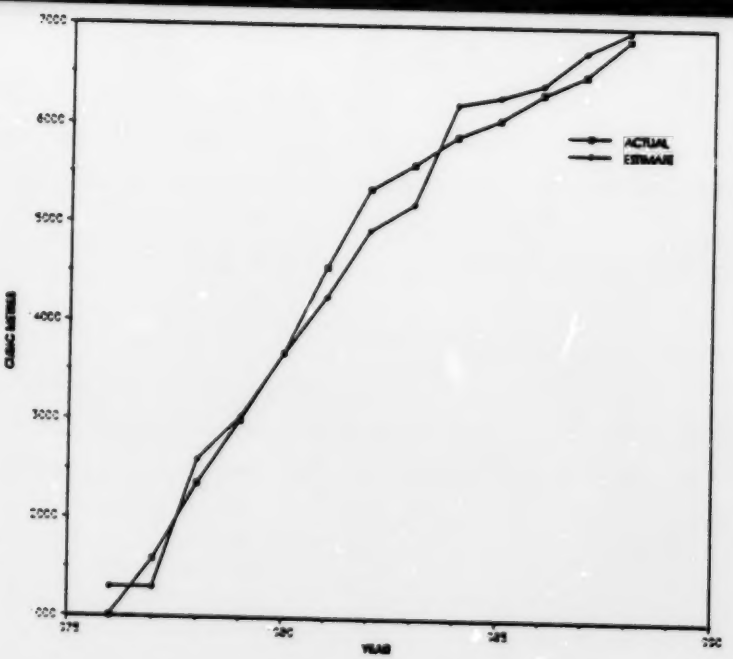


FIGURE 5B
INDUSTRIAL AND COMMERCIAL CUSTOMERS



Estimating the above equation produces the following results:

$$NDC = -50989 + 229.7\ POPEL + .6\ GDPA$$
$$(-14.2)\quad (17.1)\qquad\quad (6.4)$$

$R^2 = .99$ $\quad R^{-2} = .99$ $\quad SEE = 1040.1$ $\quad DW = 1.81$

This equation show that:

- an increase in the Edmonton CMA population by 1,000 persons results in an increase of 229 domestic customers per year; and

- a $10 million increase in the provincial gross domestic product can be expected to produce 6 new customers per year.

The above two variables explain 99 percent of the variation in the dependent variable.

3.1.2 Commercial Consumption

(a) Average Consumption

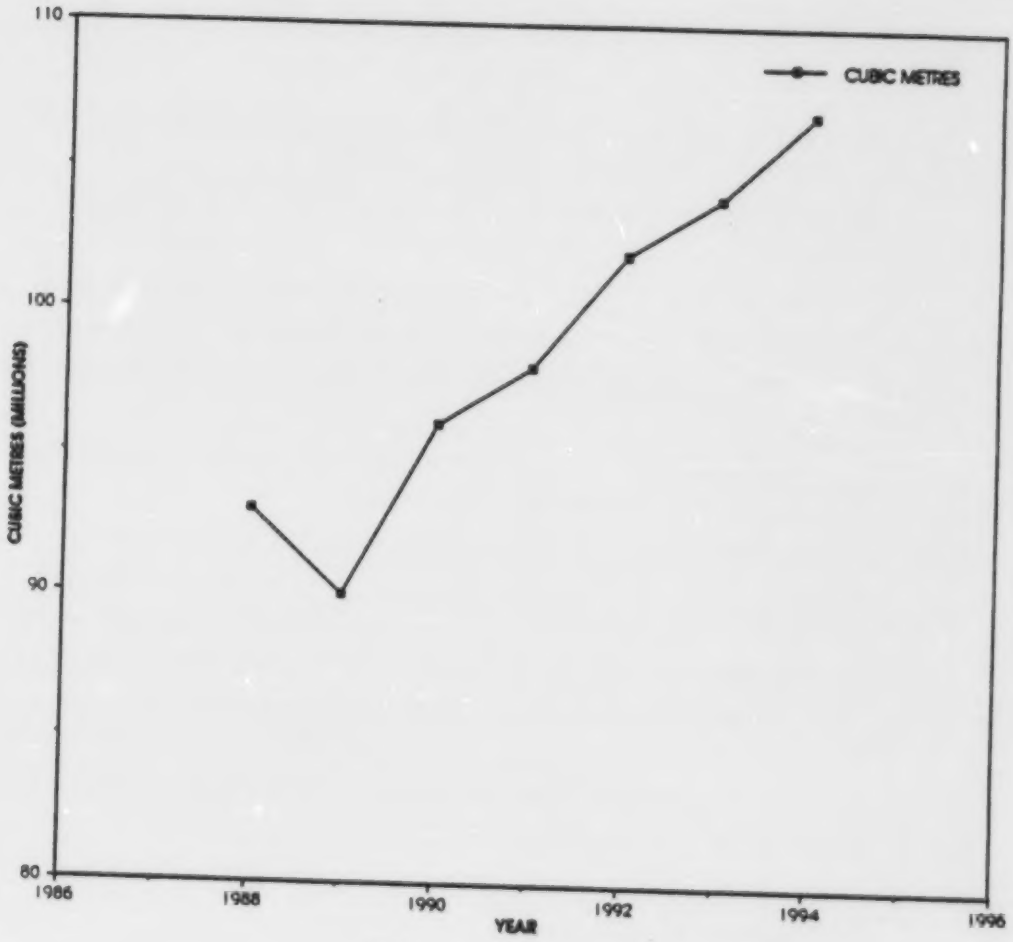
Annual average consumption per commercial customer (ACCC) is represented by the equation:

$$ACCC = L_0 + L_1\ WRCC + L_2\ IR + L_3\ POPELR$$

where $L_1 < 0$, $L_2 < 0$, $L_3 > 0$

WRCC represents the commercial water rate, IR is the interest rate, and POPELR refers to the previous year's population growth rate.

FIGURE 6
TOTAL ANNUAL WATER CONSUMPTION



Estimating the above equation and correcting for autocorrelation yields the following result:

$$ACCC = 4009.4 - 1746.3WRCC - 57.2IR + 56.3POPELR$$
$$\quad\quad (45.4) \quad (-12.1) \quad\quad (-6.8) \quad (2.2)$$

$R^2 = .93 \quad R^{-2} = .91 \quad DW = 2.02 \quad SEE = 121.2 \; RHO = .-0.63$

The equation states that:

- a 1$ increase per cubic meter in the commercial water rate results in a 1746.3 cubic meter reduction in the quantity of water consumed by an average commercial customer annually;

- a 1$ increase in the interest rate causes consumption per commercial consumer to decline by 57.2 cubic meters per annum; and

- a 1% increase in the previous year's population by one percentage point is expected to produce an increase in commercial consumption of 56.3 cubic meters per year.

The above variables together explain 93 percent of the variation in the dependent variable.

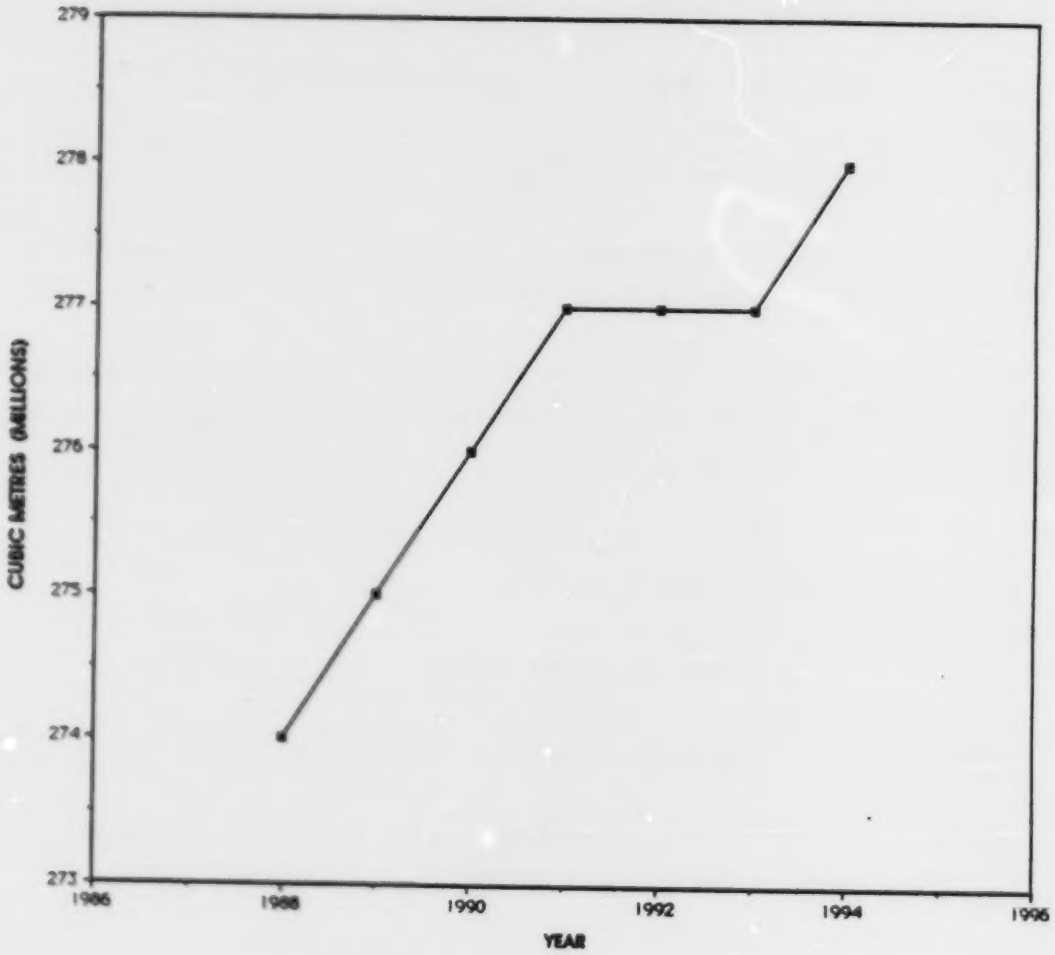
(b) Number of Customers

The number of commercial customers (NCC) per year is estimated by the following equations:

$$NCC = L_0 + L_1 \; EMPER + L_2 \; POPEL$$

where $L_1 > 0$, $L_2 > 1$

FIGURE 7
ANNUAL WATER CONSUMPTION - DOMESTIC



Estimating the above equation produces the following results:

$$NCC = -8471 + 75\ EMPER + 36\ POPEL$$
$$\quad\quad (-5.1)\quad (2.3)\quad\quad (14.2)$$

$R^2 = .95 \quad R^{-2} = .94 \quad DW = 2.46 \quad SEE = 546.7$

The equation states that:

- a 1% increase in employment is expected to result in an increase of 75 new commercial customers per year; and

- an increase in the previous years population by 1,000 persons would increase the number of commercial customers by 36 per year.

The above variables together explain 95 percent of the variation of the dependent variable.

3.1.3 Industrial Construction

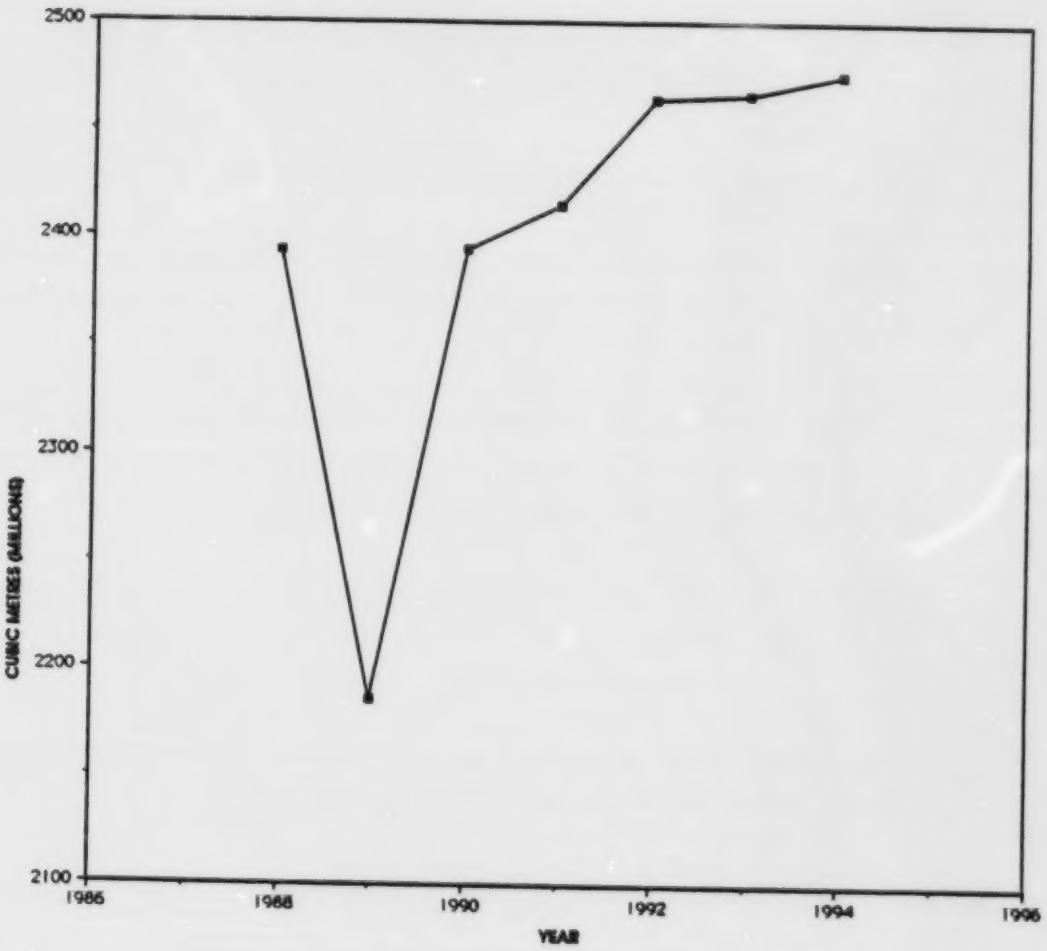
(a) Average Consumption

Annual average consumption per industrial customer (ACIC) is represented by the equation.

$$ACIC = L_1\ WRIC + L_2\ GDPALR + L_3\ EMPE$$

where $L_1 < 0$, $L_2 < 0$, $L_3 > 0$

FIGURE 8 :
TOTAL ANNUAL WATER CONSUMPTION



The estimated parameters for the above equations are as follows:

$$ACIC = -132688\ WRIC - 5198\ GDPALR + 1637\ EMPE$$
$$\qquad\quad (2.0) \qquad\quad (3.0) \qquad\quad (23.4)$$

$R^2 = .82 \quad R^{-2} = .79 \quad DW = 1.74 \quad SEE = 21289$

The equation states that:

- a 1$ increase in the water rate is expected to produce 132,688 cubic meters reduction in the quantity demanded per industrial customers.

- a 1% increase in the previous year's provincial gross domestic product would result in a reduction of 5,198 cubic meters in the average consumption per customer.

- an increase in the employed labour force by 1,000 persons will result in an increase in average consumption of 1,637 cubic meters.

The above variables explain about 82 percent of the fluctuations in the dependent variable.

3.1.4 Combined: Industrial and Commercial

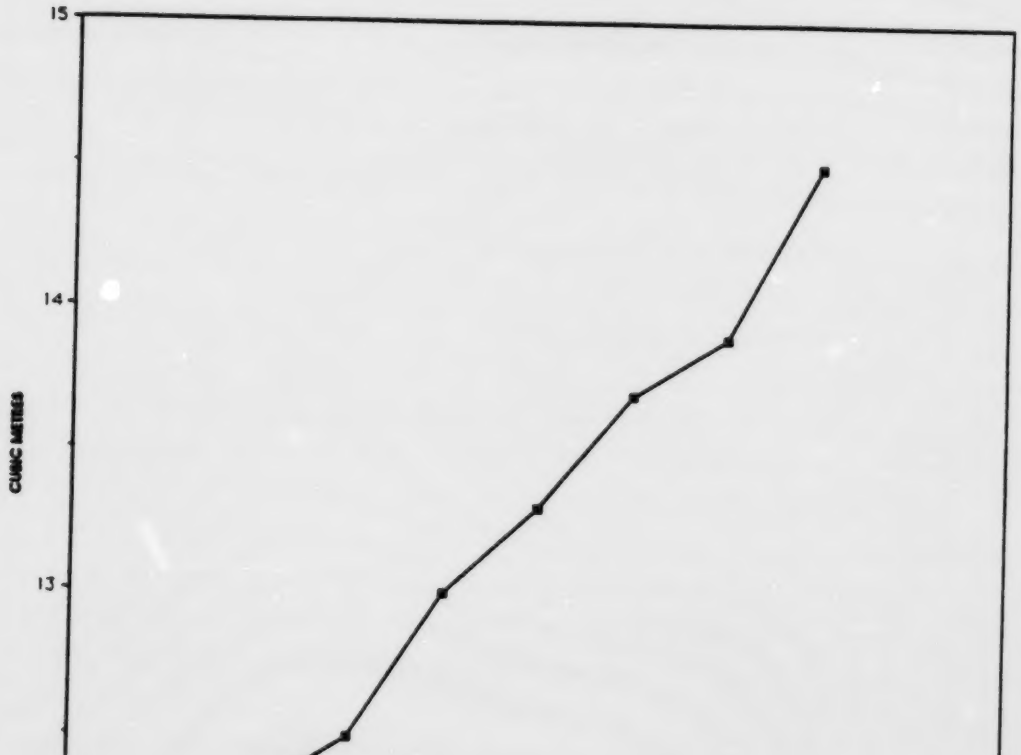
(a) Number of Customers

The total number of industrial and commercial customers (NCOMB) per year is estimated by the following equation:

$$NCOMB = L_0 + L_1\ EMPER + L_2\ POPEL$$

where $L_1 > 0$, $L_2 > 0$

FIGURE 9
ANNUAL WATER CONSUMPTION - INDUSTRIAL



EMPER refers to the growth rate of the employment and POPEL is the previous year's population.

Estimating the above equation produces the following results:

$$NCOMB = -8452 + 75.8\ EMPER + 36\ POPEL$$
$$(-5.1)\ (2.3)\qquad (14.2)$$

$R^2 = .95$ $R^{-2} = .95$ $DW = 2.4$ $SEE = 546.7$

The equation states that:

- a 1% increase in employment is expected to increase the number of commercial and industrial customers by 76 per year; and

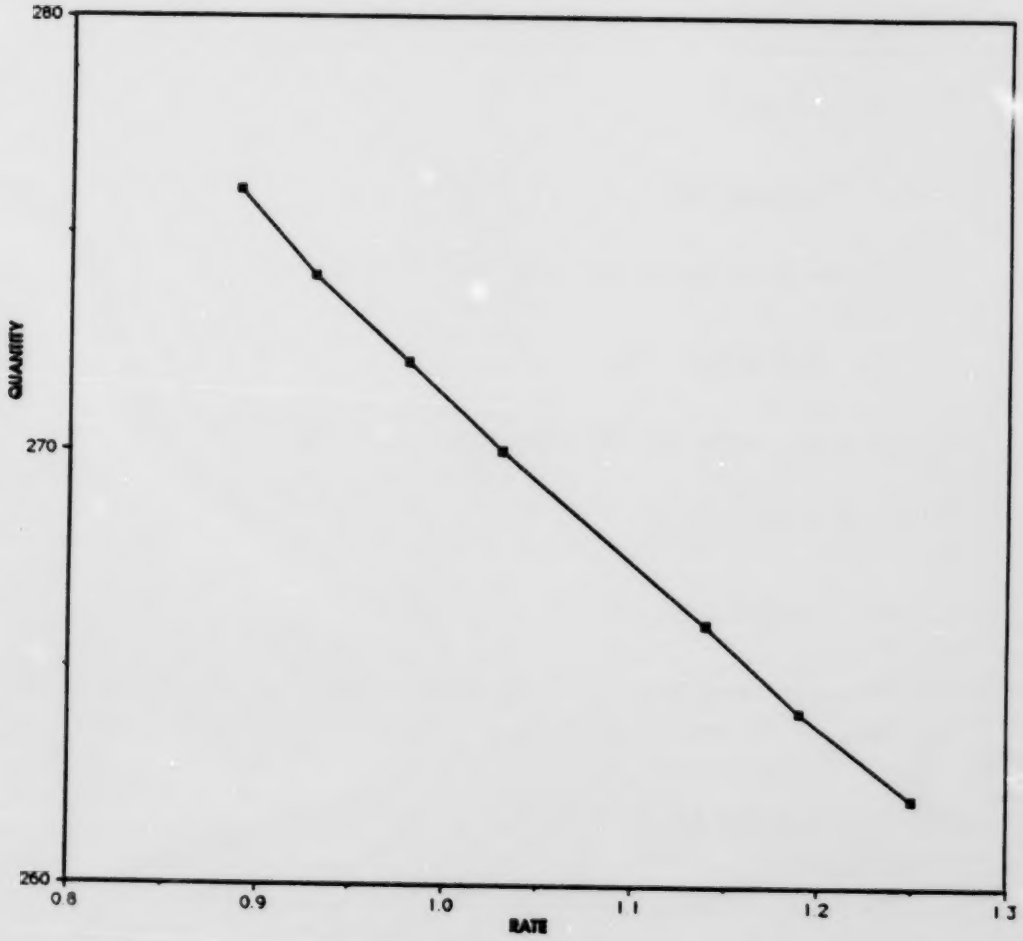
- a 1,000 increase in the previous year's population is expected to result in an increase in the number of industrial and commercial customers by 36 per year.

These variables explain 95 percent of the variation in the dependent variable.

3.2 Simulation

In this section the model's results are checked to determine whether it is well constructed; validation is done by simulating the model over a sample period 1976 - 1988. The model's predications of the endogenous variables are compared to the actual values over the sample period. The difference between the actual value and the simulated value (the error) is expressed as percentage of the actual value. Some writers (Rubin 1981) contend that a model for which most error terms are less than 10% should

FIGURE 10
DOMESTIC AVERAGE WATER CONSUMPTION RATE IMPACT



be considered to be performing acceptably. The detailed results from the simulation are shown in Appendix A. The following present a summary of the errors in the simulations. (See Figures 4 and 5).

3.2.1 Domestic

(a) Consumption

All the error terms are less than 6% (Figure 4A).

(b) Customers

The error terms are all less than 3.0% (Figure 4B).

3.2.2 Commercial

(a) Consumption

The error terms are all less than 7.5%. The largest error 7.3% occurred in 1978 (Figure 4C).

(b) Customers

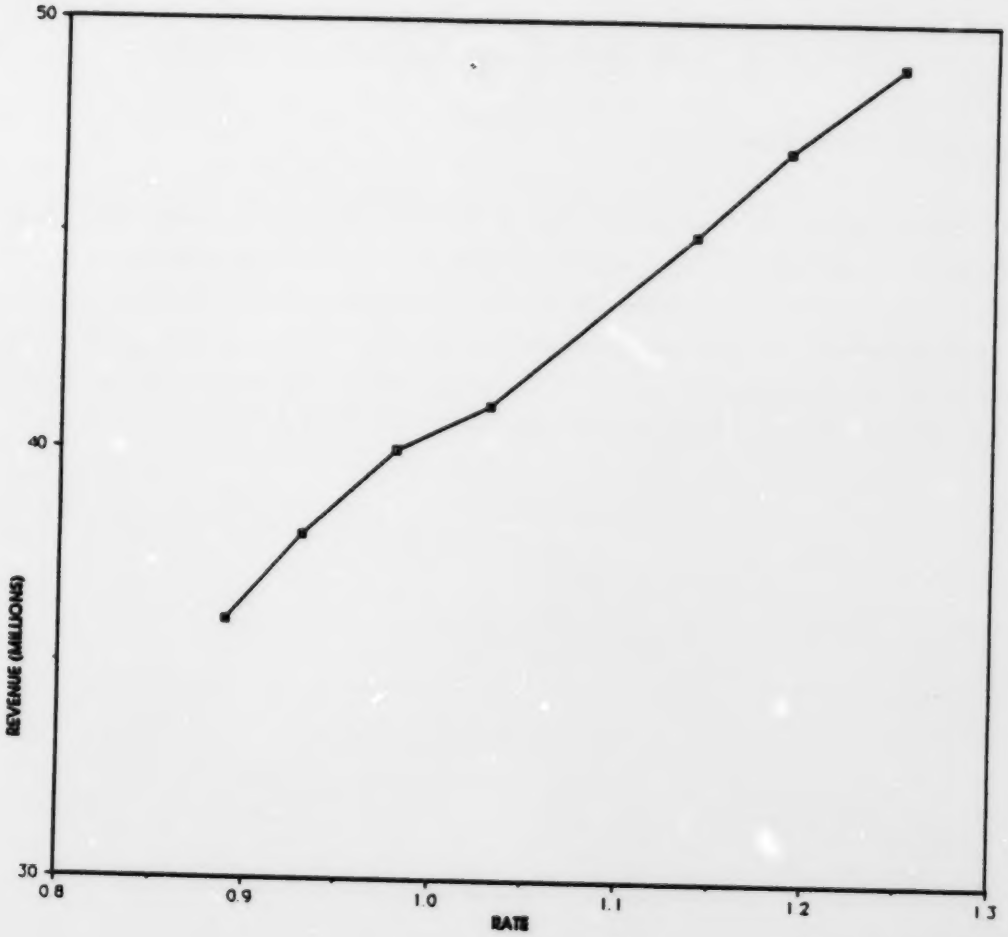
The error terms are all less than 3.3% (Figure 4D).

3.2.3 Industrial

(a) Consumption

The largest deviation occurred in 1981 when the error term was estimated at 10.3% (Figure 5A).

FIGURE 11
TOTAL REVENUE - DOMESTIC, RATE IMPACT



3.2.4 Combined

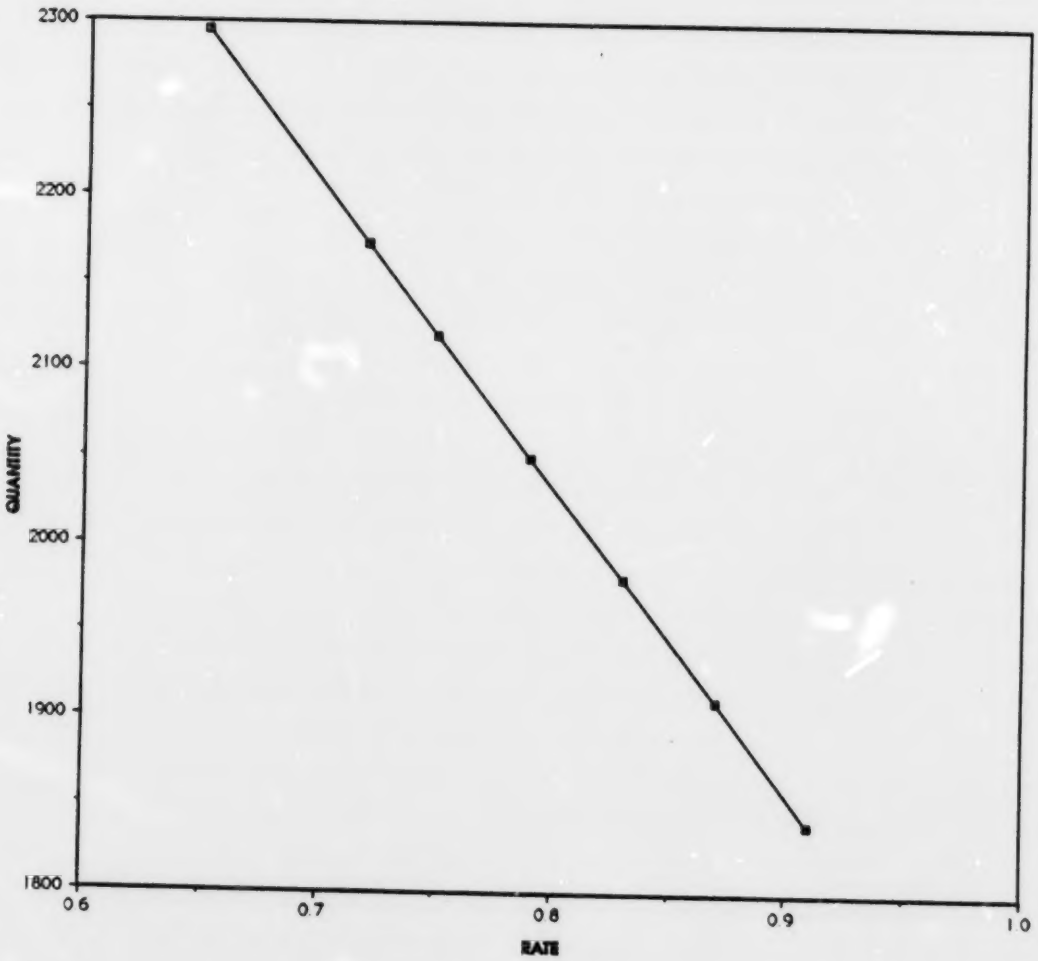
(a) Customers

The error terms are all less than 3.3% (Figure 5B).

Conclusions from Simulation

The error terms for most of the equations are less than 10%; the only deviation occurred in the equation for industrial consumption (10.3%) for 1981. This deviation (10.3%) is close to the pre-defined standard of 10%. As a consequence, it can be concluded that the model provides a reasonable estimate of the sample period and thus could be expected to provide an acceptable forecast of water consumption.

FIGURE 12
COMMERCIAL AVERAGE WATER CONSUMPTION: RATE IMPACT



4. MODEL APPLICATIONS

4.1 The Model

The Edmonton Water Consumption Model is comprised of a set of estimated stochastic equations and accounting equations (See Appendix A). The stochastic equations were described in Section 3 and the accounting equations are as follows:

The accounting identities are as follows:

(a) $TC = TDC + TCC + TIC$

where: TC = Total Annual Consumption
TDC = Total Annual Domestic Consumption
TCC = Total Annual Commercial Consumption
TIC = Total Annual Industrial Consumption

(b) $TDC = ACDC \times NDC$

where: ACDC = Average Annual Domestic Consumption
NDC = Number of Domestic Customers

(c) $TCC = ACCC \times NCC$

where: ACCC = Average Annual Commercial Consumption
NCC = Number of Commercial Customers

(d) $TIC = ACIC \times NIC$

where: ACIC = Average Annual Industrial Consumption
NIC = Number of Industrial Customers

(e) NIC = NCOMB - NCC

where: NCOMB = Number of Commercial and Industrial Customers

(f) REV = REVC + REVD + REVI

where: REV = Total Annual Revenues
REVC = Revenues from Commercial Sales
REVD = Revenues from Domestic Sales
REVI = Revenues from Industrial Sales

(g) REVC = ACCC x NCC x WRCC
REVD = ACDC x NDC x WRDC
REVI = ACIC x NIC x WRIC

4.2 Forecasting Water Consumption

The forecast for water consumption is driven by developments in the Alberta and Edmonton economies. Values for these economic variables are based on the forecasts prepared by the City Forecast Committee on January 26, 1989. The difficulty in predicting some exogenous variables in the model necessitated additional assumptions. Average temperatures for the six months from April to September inclusive are assumed to hold constant for the rest of the forecast period at the 1988 level. In addition the three water rates (domestic, commercial and industrial) are also assumed to hold constant at their 1988 values for the rest of the forecast period. These assumptions allow the users to assess the impacts of economic conditions on water usage.

TABLE 1

FORECASTING ASSUMPTIONS

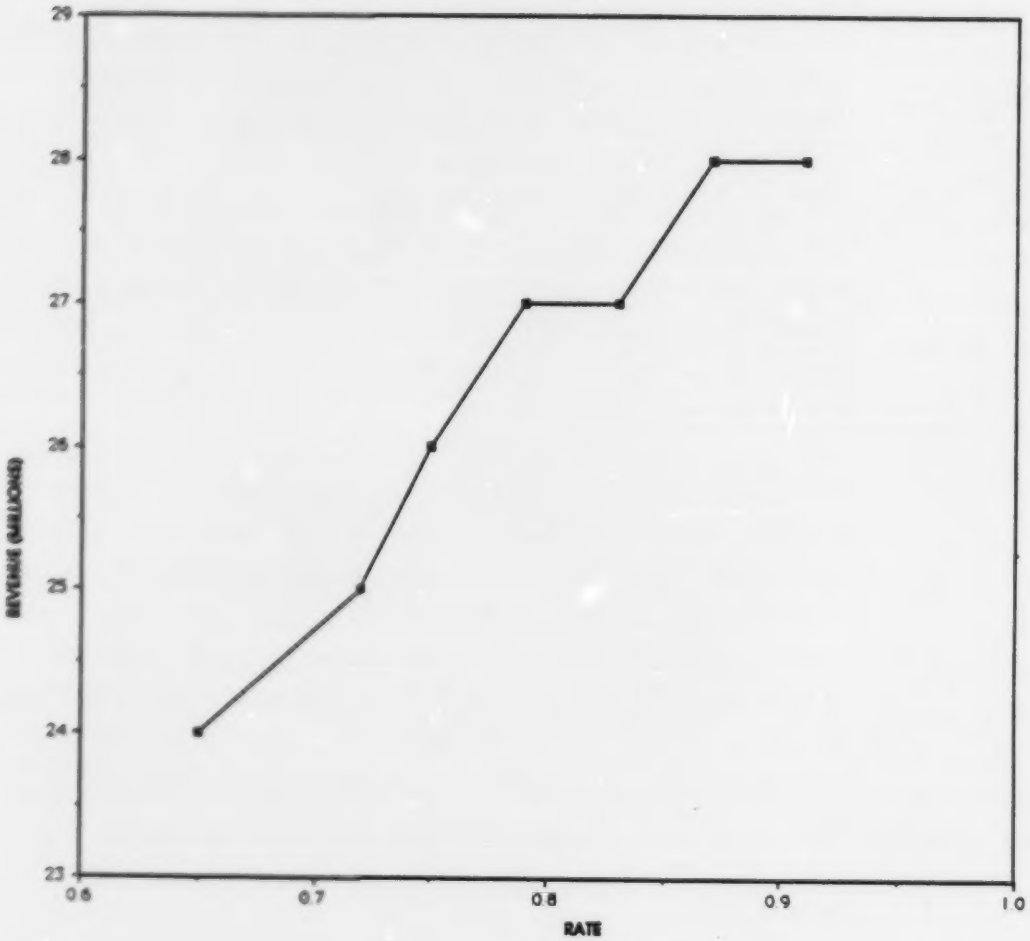
ID	AVETEMP :A	DROPR :A	EMPE :A	EMPER :A	GDPA :A
1988	13.7	-2.6	356	3.1	59879
1989	13.7	-.5	362	1.6	62274
1990	13.7	.5	368	1.6	64765
1991	13.7	.5	376	2.1	67356
1992	13.7	.5	384	2.1	70724
1993	13.7	.0	392	2.0	73552
1994	13.7	1.0	401	2.2	75759

ID	GDPALR :A	IR :A	POPEL :A	POPELR :A	WRCC :A
1988	4.7	10.8	698.9	.5	.6498
1989	4.9	12.0	698.9	0.0	.6498
1990	3.9	10.5	705.9	.9	.6498
1991	4.0	9.5	713.8	1.1	.6498
1992	4.0	9.2	722.8	1.2	.6498
1993	5.0	9.0	732.5	1.3	.6498
1994	3.9	9.0	742.1	1.3	.6498

ID	WRDC :A	WRIC :A
1988	.8899	.46
1989	.8899	.56
1990	.8899	.46
1991	.8899	.46
1992	.8899	.46
1993	.8899	.46
1994	.8899	.46

Total annual water consumption is projected to increase from 93 million cubic meters in 1988 to 107 million cubic meters by 1994; this represents an increase of 15% over the period. By customer class, domestic consumption is forecasted to increase by 15.5% over this period, climbing from 40.8 million cubic meters in 1988 to 47.1 million cubic meters in 1994. Industrial consumption is expected to total 12 million cubic meters in 1988 and then grow to 14 million cubic meters by 1994. Commercial usage is expected to

FIGURE 13
TOTAL REVENUE - COMMERCIAL RATE IMPACT



decline to 36.6 million cubic meters in 1989 from 40.3 million cubic meters in 1988 and then increase steadily to 45.4 million cubic meters in 1994 (Appendix B).

The numbers of customers connected to the water system are forecasted to increase in all three customer classes (Figures 6-9). The total domestic customers are projected to climb from 148,000 households in 1988 to 169,000 households in 1994 or by 14.0%. Commercial customers are expected to increase from 16,800 units in 1988 to 18,300 units in 1994 or by 8.9%. The number of industrial customers is expected to remain constant at around 25 units between 1988 and 1994. As a result, the combined total of industrial and commercial customers are forecasted to grow from 16,884 units n 1988 to 18,371 units in 1994.

The cotal water sale revenues are forecasted to decline from $68 million in 1988 to $66 million by 1989 and then climb to $78 million by 1994. The total domestic sale revenues are expected to grow from $36 million in 1988 to $42 million by 1994 or by 16.6%. Industrial sale revenues are projected to climb from $5.6 million in 1988 to $6.7 million in 1994. Commercial sale revenues are estimated at $26 million in 1988 and is expected to decline to $24 million in 1989 and then recover strongly to reach $30 million in 1994.

4.3 Rate Analysis

The purpose of this section is to estimate the impact of water rate changes on the quantity of water demanded. This is accomplished by holding all other variables constant and allowing only the water rate to vary. This sensitivity analysis also allows the users to evaluate the impact of rate on revenues (Appendix C).

(a) Domestic

The domestic water rate is assumed to rise from $0.89 per cubic meter to $1.25. This results in a fall of the quantity demanded of water per household from 275 to 262 cubic meters (see Figure 11). This simulation shows that a 40.4% increase in the water rate produces a 3.5% decrease in water consumption per household.

The econometric equation that was used in Section 3 to specify the domestic demand for water can be re-specified in logarithmic terms. The estimated coefficients for this equations represent water demand elasticities (Klein 1962). The estimated equation is as follows:

$$\log ACDC = 4.4 + .44 \log AVETEMP - .02 \log IR$$
$$(13.8)\ (3.4)\qquad\qquad (0.9)$$

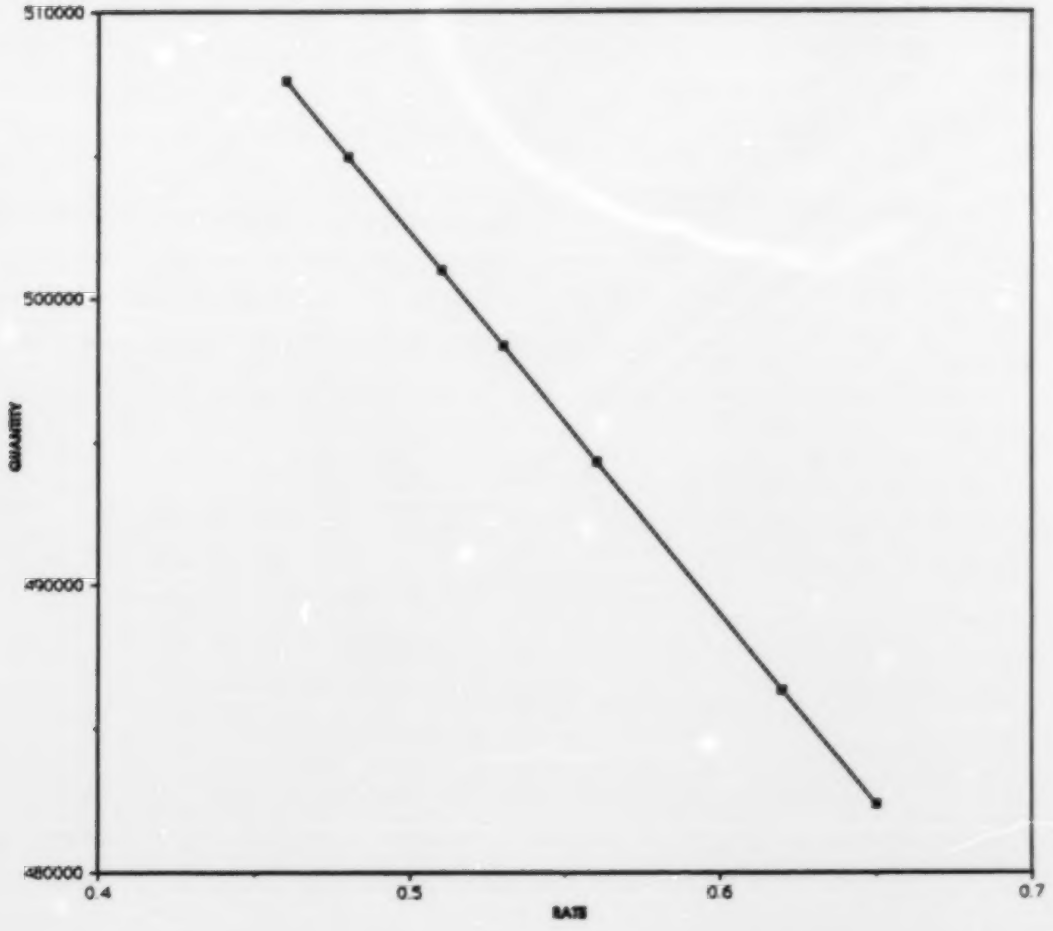
$$-.06 \log WRDC + .01 \log DPOPR$$
$$(-5.7)\qquad\quad (2.2)$$

$R^2 = .79$ $\quad R^{-2} = .72$ $\quad DW = 1.87$ $\quad SEE = .02$

The estimated coefficient for the water rate (WRDC) is .06. This indicates that the domestic demand for water is inelastic or unresponsive to changes in water rates.

The implication for policy is that a percentage increase in the water rate will result in a less than corresponding decreases in the quantity of water consumed domestically. As a result, an increase in the water rate tends to result in an increase in revenues. For instance, an increase of the domestic water rate from $0.89 to $1.25 per cubic meter results in a decrease in the average water demand per household from 274.8 to 261.1 cubic meters. The revenue from the average household will rise from

FIGURE 14
INDUSTRIAL AVERAGE WATER CONSUMPTION: RATE IMPACT



$244.58 to $326.37 and total revenues from domestic sales are estimated to increase from $36 million to $48 million (Figure 11).

(b) Commercial

The commercial water rate is assumed to rise from $0.6498 to $0.9100 per cubic meter and the quantity of water demanded per commercial customer is estimated to fall from 2,295 to 1,840 cubic meters (see Figure 12 and 13).

The econometric equation that was used to estimate the commercial demand for water was re-formulated in logarithmic terms. The estimated equation is as follows:

$$\log ACCC = 8.15 - .14 \log WRCC - .17 \log IR + .06\ POPELR$$
$$(33.4)\quad (-3.1)\qquad (1.8)\qquad (1.6)$$

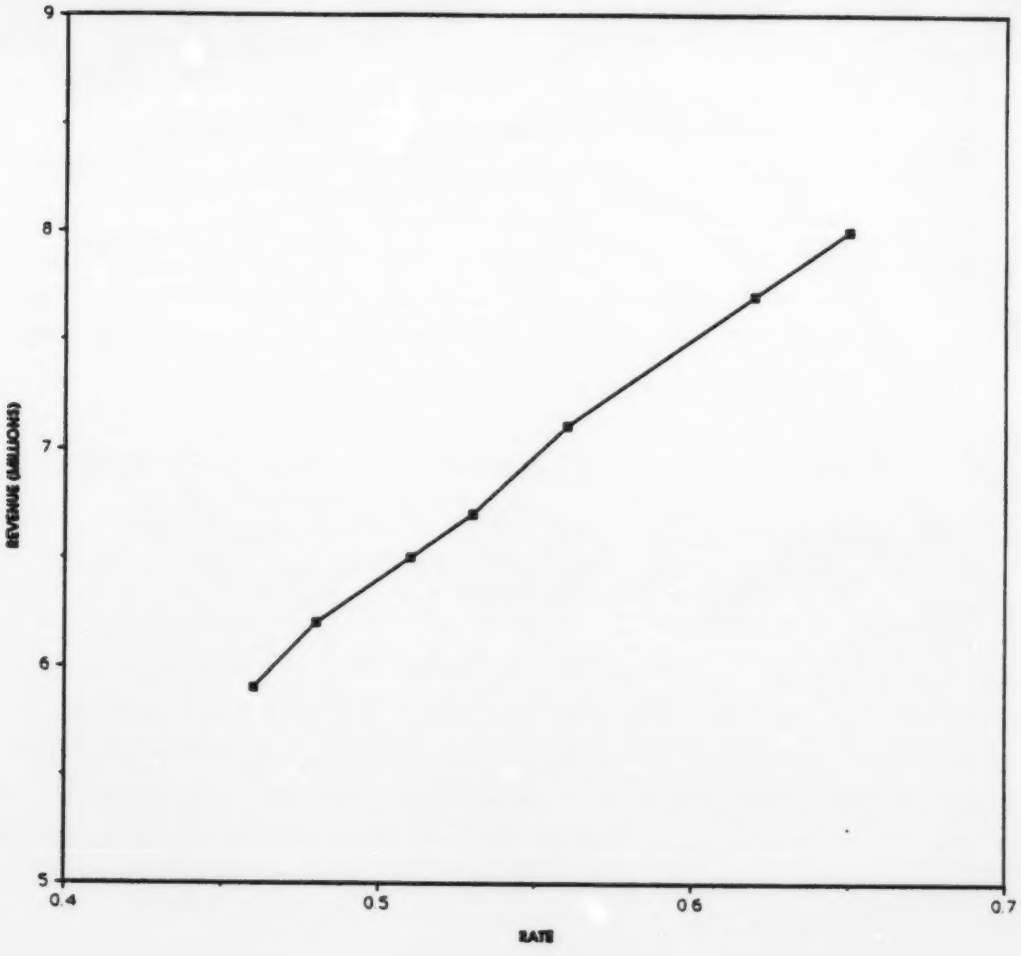
$R^2 = .78 \quad R^{-2} = .72 \quad DW = 2.6 \quad SEE = .07$

The estimated coefficient for the water rate (WRCC) is 0.14 which is substantially less than one. The demand for water is therefore inelastic. Total commercial revenues are therefore expected to increase following a water rate increase. For example when the commercial rate was $0.6498, total revenues were $25 million and then rose to $28 million as the rate was changed to $2.47 (Figure 14).

(c) Industrial

The industrial water rate is assumed to increase from $0.46 to $0.65 per cubic meter and the quantity of water demanded per industrial customer is estimated to fall from 507,572 to 482,362 cubic meters (see Figure 14).

FIGURE 15
TOTAL REVENUE - INDUSTRIAL: RATE IMPACT



The equation that was used to estimate industrial water demand is re-formulated in logarithmic terms. The new estimated equation becomes:

$$\log ACIC = \underset{(5.2)}{-0.3} \log WRIC \underset{(2.9)}{-0.9} \log GDPALR + \underset{(176.5)}{2.2} \log EMPE$$

$R^2 = .81$ $R^{-2} = .77$ DW = 1.74 SEE = 4.67

The estimated coefficient for the water rate (WRIC) is 0.3 which is much less than one. The demand for water is therefore inelastic. The total industrial revenues are therefore expected to increase following a rate increase. For example, an industrial rate of $0.46 is expected to produce revenues of $5,998,000 and a rate of $0.56 should generate revenues of $8,055,000 (Figure 15).

Summary

The computed elasticities for the three segments of the water consumption are all less than one and thus indicating that water demand is inelastic. This conclusion is expected. Water is a necessity since, there are no close substitutes for its use. As a result, the water user is unable to vary his/her consumption even though a price increase has been imposed.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The research project was able to satisfy the following objectives:

- identify factors that influence water consumption in Edmonton;
- estimate the statistical relationship between annual water consumption and the factors identified above;
- forecast water consumption over the next five years based on the model; and
- undertake a sensitivity analysis of water rate increases.

A simulation of the model over the sample period 1973-1988 showed that the model was capable of estimating that period with a great degree of accuracy. As a result, a high level of confidence can be placed in the model's output.

The demand equations that were derived for the various groups of consumers-domestic, commercial and industrial-would assist the user in assessing the change in the quantity demanded that results from a change in the water rate. In addition, the user would be able to estimate the revenue impact that resulted from a change in the water rate.

5.2 Recommendations

For the model to be useful as a forecasting and analytical tool, monitoring the results of the model on an annual basis should be carried out by noting the deviation between the forecasted and actual results. A deviation of more than 10 percent between forecasted and actual should be regarded as a sign that the model should be updated to consider the latest information.

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APPENDIX A

MODEL

- Variable Listing
- Model Equations
- Simulation Results
- Historical Data

VARIABLE LISTING

ACCC	=	Average Consumption per Commercial Customer in cubic meters
ACDA	=	Average Consumption per Domestic Customer in cubic meters
ACIC	=	Average Consumption for Industrial Customer in cubic meters
AVETEMP	=	Average Spring and Summer Temperature in centigrade
DPOP	=	Housekeeping Population (000)
EMPE	=	Edmonton CMA's Employment (000)
GDPA	=	Alberta's Gross Domestic Product in ($1981 MILLION)
NCC	=	Number of Commercial Customers
NDC	=	Number of Domestic Customers
NIC	=	Number of Industrial Customers
POPE	=	Edmonton CMA's population (000)
REV	=	Total Revenues
REVC	=	Total Revenues Commercial
REVD	=	Total Revenues Domestic
REVI	=	Total Revenues Industrial
TCC	=	Total Consumption Commercial
TDC	=	Total Consumption Domestic
TIC	=	Total Consumption Industrial
WRCC	=	Commercial Water Rate in dollars per Cubic Meter
WRDC	=	Domestic Water Rate in dollars per Cubic Meter
WRIC	=	Industrial Water Rate in dollars per Cubic Meter

Note: The transformation varibles have the following suffix:

Lagged Variable = L
Growth Variable = R
Lagged Growth = LR

WATER CONSUMPTION FORECASTING MODEL
==========
Equations

AINDC : ACIC=-132687*WRIC-5199.2*GDPALR+1637.3*EMPE-14270

AVCOM : ACCC=4007.8-625.41*WRCC-56.852*IR+57.555*POPELR-.61583
*(ACCC(-1)-(4007.8-625.41*WRCC(-1)-56.852*IR(-1)+57.555*POPELR(-1)))+62.21

COM2 : NCC=-8471.2+75.911*EMPER+36.019*POPEL-87

COMB : NCOMB=-8452.1+75.877*EMPER+36.027*POPEL-86

CON : TCC=NCC*ACCC

DCON : TDC=NDC*ACDC

DOM8 : ACDC=172.99+9.9797*AVETEMP-.87185*IR-38.109*WRDC+.63111 *DPOPR+7.74

DOMCOS : NDC=-50989+229.71*POPEL+.68155*GDPA+.27107*(NDC(-1)-(-50989+229.71*POPEL(-1)+.
68155*GDPA(-1)))-1554

ICO : TIC=NIC*ACIC

IND : NIC=NCOMB-NCC

RC : REVC=ACCC*NCC*WRCC

RD : REVD=ACDC*WRDC*NDC

RI : REVI=WRIC*NIC*ACIC

TCON : TC=TDC+TCC+TIC

TREV : REV=REVC+REVD+REVI

MODEL SIMULATION 1976 - 1988

ID	ACCC :A	ACCC :S	RESID	RATIO RESID
1976	3564.70	3586.99	-22.29	-.0062
1977	3323.46	3103.47	219.98	-.0061
1978	3061.85	3286.89	-225.04	-.0735
1979	2980.43	2887.44	92.98	.0312
1980	2609.69	2645.90	-36.21	-.0138
1981	2493.48	2529.04	-35.56	-.0142
1982	2808.79	2862.11	-53.32	-.0189
1983	2657.10	2749.94	-92.84	-.0349
1984	2529.92	2601.44	-71.52	-.0282
1985	2485.66	2528.93	-43.27	-.0174
1986	2458.22	2472.24	-14.02	-.0057
1987	2367.96	2469.08	-101.12	-.0427
1988	2393.30	2329.13	64.16	.0268

ID	ACDC :A	ACDC :S	RESID	RATIO RESID
1976	297.520	304.372	-6.85	-.023
1977	285.910	294.566	-8.65	-.030
1978	282.380	290.734	-8.35	-.029
1979	266.960	278.471	-11.51	-.043
1980	275.910	284.663	-8.75	-.032
1981	278.510	287.855	-9.34	-.033
1982	273.630	282.256	-8.62	-.031
1983	281.430	290.614	-9.18	-.033
1984	271.260	279.377	-8.11	-.029
1985	262.580	268.538	-5.96	-.023
1986	259.880	272.126	-12.24	-.047
1987	261.550	276.619	-15.06	-.057
1988	274.290	274.262	0.03	9.89E-5

ID	ACIC :A	ACIC :S	RESID	RATIO RESID
1976	426590.	410371.	16218.2	.038018
1977	410090.	383875.	26214.3	.063923
1978	409190.	410587.	-1397.84	-.003416
1979	423[illegible]90.	437942.	-14452.4	-.034127
1980	440520.	446532.	-6012.43	-.013648
1981	569270.	510358.	58911.2	.103485
1982	503480.	475283.	28196.9	.056004
1983	492820.	493430.	-610.250	-.001238
1984	494840.	488516.	6324.03	.012779
1985	472650.	454099.	18550.8	.039248
1986	475540.	450567.	24972.6	.052514
1987	506990.	482905.	24084.7	.047505
1988	482980.	482976.	3.43750	7.11E-6

ID	NCC :A	NCC :S	RESID	RATIO RESID
1976	10994.0	11193.3	-199.320	-.018129
1977	11559.0	11186.1	372.838	.032255
1978	12330.0	12488.1	-158.109	-.012823
1979	12976.0	12928.3	47.6171	.003669
1980	13652.0	13555.9	96.0947	.007038
1981	14539.0	14143.8	395.117	.027176
1982	15328.0	14828.8	499.114	.032562
1983	15579.0	15094.8	484.146	.031076
1984	15870.0	16104.8	-234.815	-.014796
1985	16046.0	16158.1	-112.143	-.006988
1986	16309.0	16310.8	-1.86621	-1.14E-4
1987	16492.0	16651.9	-159.966	-.009699
1988	16859.0	16858.9	.044921	2.66E-6

ID	NCOMB :A	NCOMB :S	RESID	RATIO RESID
1976	11017.0	11217.6	-200.617	-.018209
1977	11583.0	11210.7	372.207	.032133
1978	12354.0	12512.5	-158.507	-.012830
1979	13001.0	12952.9	48.0957	.003699
1980	13682.0	13580.5	101.444	.007414
1981	14564.0	14168.7	395.295	.027141
1982	15353.0	14854.3	498.632	.032477
1983	15601.0	15120.4	480.508	.030799
1984	15891.0	16130.2	-239.266	-.015056
1985	16070.0	16183.6	-113.656	-.007072
1986	16331.0	16336.4	-5.44433	-3.33E-4
1987	16516.0	16677.5	-161.544	-.009781
1988	16884.0	16884.5	-.539062	-3.19E-5

ID	NDC :A	NDC :S	RESID	RATIO RESID
1976	97613.0	96450.6	1162.31	.011907
1977	101774.	100529.	1245.04	.012233
1978	107349.	105350.	1998.30	.018615
1979	113472.	111460.	2011.68	.017728
1980	120535.	116871.	3663.09	.030390
1981	127089.	123026.	4062.50	.031965
1982	132340.	130875.	1464.78	.011068
1983	136597.	132907.	3690.03	.027014
1984	140021.	137272.	2748.87	.019631
1985	142618.	140229.	2388.12	.016744
1986	144601.	142157.	2443.31	.016896
1987	146523.	145374.	1148.68	.007839
1988	148821.	148243.	577.84	.003882

ID	NIC :A	NIC :S	RESID	RATIO RESID
1976	23.0000	24.2968	-1.29687	-.056385
1977	24.0000	24.6318	-.631835	-.026326
1978	24.0000	24.3984	-.398437	-.016601
1979	25.0000	24.5214	.478515	.019140
1980	30.0000	24.6503	5.34960	.178320
1981	25.0000	24.8212	.17871	.007148
1982	25.0000	25.4814	-.481445	-.019257
1983	22.0000	25.6377	-3.63769	-.165349
1984	21.0000	25.4511	-4.45117	-.211960
1985	24.0000	25.5127	-1.51269	-.063028
1986	22.0000	25.5781	-3.57812	-.162642
1987	24.0000	25.5781	-1.57812	-.065755
1988	25.0000	25.5839	-.58398	-.023359

ID	REV :A	REV :S	RESID	RATIO RESID
1976	1.465E7	1.493E7	-278434	-.018994
1977	1.984E7	1.908E7	759178	.038249
1978	2.281E7	2.388E7	-1.071E6	.046947
1979	2.431E7	2.429E7	141105	5.80E4
1980	2.738E7	2.708E7	298624	.010903
1981	2.988E7	2.945E7	427956	-.014319
1982	3.836E7	3.843E7	-71888	-.001873
1983	4.193E7	4.267E7	-732368	-.017462
1984	4.705E7	4.889E7	-1.844E6	-.039197
1985	5.125E7	5.207E7	-822336	-.016044
1986	5.632E7	5.781E7	-1.487E6	-.026417
1987	6.196E7	6.501E7	-3.043E6	-.049118
1988	6.809E7	6.747E7	628472	.009228

ID	REVC :A	REVC :S	RESID	RATIO RESID
1976	6.921E6	7.090E6	-169547	-.024497
1977	9.223E6	8.335E6	888336	.096310
1978	1.013E7	1.101E7	-884250	-.087266
1979	1.065E7	1.028E7	370280	.034752
1980	1.044E7	1.051E7	-70382	-.006740
1981	1.152E7	1.136E7	155235	.013300
1982	1.642E7	1.618E7	233123	.014197
1983	1.761E7	1.766E7	-48946	-.002778
1984	1.964E7	2.049E7	-854258	-.043484
1985	2.127E7	2.179E7	-521562	-.024520
1986	2.350E7	2.363E7	-136736	-.005818
1987	2.427E7	2.555E7	-1.281E6	-.052818
1988	2.621E7	2.551E7	702992	.026812

ID	REVD :A	REVD :S	RESID	RATIO RESID
1976	6.461	6.550	-88197	-.013648
1977	9.049	9.240	-191009	-.021107
1978	1.091	1.106	-151293	-.013863
1979	1.175	1.208	-328841	-.027978
1980	1.443	1.448	-50550	-.003502
1981	1.537	1.542	-53706	-.003492
1982	1.867	1.909	428770	-.022964
1983	2.118	2.134	-159048	-.007508
1984	2.387	2.417	-296024	-.012398
1985	2.578	2.599	-211312	-.008194
1986	2.853	2.944	-915432	-.032082
1987	3.234	3.402	-1.680E6	-.051968
1988	3.632	3.627	55224	.001520

ID	REVI :A	REVI :S	RESID	RATIO RESID
1976	1.275E6	1.296E6	-20693.7	-.016223
1977	1.574E6	1.512E6	61855.6	.039279
1978	1.767E6	1.803E6	-35485.5	-.020074
1979	1.905E6	1.933E6	-27314.8	-.014333
1980	2.510E6	2.091E6	419596.	.167105
1981	2.988E6	2.660E6	328437.	.109894
1982	3.272E6	3.148E6	123786.	.037824
1983	3.144E6	3.668E6	-524428.	-.166792
1984	3.533E6	4.227E6	-694165.	-.196471
1985	4.197E6	4.286E6	-89426.5	-.021306
1986	4.289E6	4.725E6	-435742.	-.101586
1987	5.353E6	5.434E6	-80982.0	-.015126
1988	5.554E6	5.683E6	-129704.	-.023352

ID	TC :A	TC :S	RESID	RATIO RESID
1976	7.804E7	7.955	-1.515	-.019419
1977	7.735E7	7.388	3.472	.044886
1978	7.788E7	8.179	-3.911	-.050226
1979	7.955E7	7.920	344672.	.004332
1980	8.209E7	8.024	1.851	.022552
1981	8.588E7	8.395	1.922	.022385
1982	9.185E7	9.159	255648.	.002783
1983	9.067E7	9.289	-2.211	-.024392
1984	8.852E7	9.278	-4.258	-.048104
1985	8.867E7	9.020	-1.526	-.017215
1986	8.813E7	9.063	-2.501	-.028387
1987	8.954E7	9.378	-4.238	-.047333
1988	9.324E7	9.238	861856	.009243

ID	TCC :A	TCC :S	RESID	RATIO RESID
1976	3.919E7	4.015	-960064	-.024497
1977	3.841E7	3.471	3.699E6	.09631
1978	3.775E7	4.104	-3.294E6	-.087266
1979	3.867E7	3.733	1.344E6	-.034752
1980	3.562E7	3.586	-240132	-.006740
1981	3.625E7	3.577	482176	.013300
1982	4.305E7	4.244	611232	.014197
1983	4.139E7	4.151	-115032	-.002778
1984	4.014E7	4.189	-1.745E6	-.043484
1985	3.988E7	4.086	-977988	-.024520
1986	4.009E7	4.032	-233260	-.005818
1987	3.905E7	4.111	-2.062E6	-.052818
1988	4.034E7	3.926	1.081E6	.026812

ID	TDC :A	TDC :S	RESID	RATIO RESID
1976	2.904E7	2.943	-396392	-.013649
1977	2.909E7	2.971	-614176	-.021107
1978	3.031E7	3.073	-420260	-.013863
1979	3.029E7	3.114	-847530	-.027978
1980	3.325E7	3.337	-116474	-.003502
1981	3.539E7	3.551	-123632	-.003492
1982	3.621E7	3.704	-831592	-.022964
1983	3.844E7	3.873	-288656	-.007508
1984	3.798E7	3.845	-470928	-.012398
1985	3.744E7	3.775	-306872	-.008194
1986	3.757E7	3.878	-1.99E6	-.032082
1987	3.832E7	4.031	-1.99E6	-.051908
1988	4.082E7	4.075	62056	.001520

ID	TIC :A	TIC :S	RESID	RATIO RESID
1976	9.811E6	9.970E6	-159182.	-.016223
1977	9.842E6	9.455E6	386597.	.039279
1978	9.820E6	1.001E7	-197142.	-.020074
1979	1.058E7	1.073E7	-151749.	-.014333
1980	1.321E7	1.100E7	2.208E6	.167105
1981	1.423E7	1.266E7	1.563E6	.109894
1982	1.258E7	1.211E7	476101.	.037824
1983	1.084E7	1.265E7	-1.808E6	-.166792
1984	1.039E7	1.243E7	-2.041E6	-.196471
1985	1.134E7	1.158E7	-241693.	-.021306
1986	1.046E7	1.152E7	-1.062E6	-.101586
1987	1.216E7	1.235E7	-184050.	-.015126
1988	1.207E7	1.235E7	-281965.	-.023352

HISTORICAL DATA 1971-1988

	ACCC	TCC	ACDC	TDC	ACIC
1971			299.05	25427324.35	
1972			279.21	24206669.37	
1973	3095.59	30411076.16	280.02	24772809.36	560350.00
1974	3560.72	36280176.08	380.64	25502598.72	457900.00
1975	2943.48	38621401.08	293.00	27453514.00	463080.00
1976	3564.70	39190311.80	297.52	29041819.76	426590.00
1977	3323.46	38415874.14	285.91	29098204.34	410090.00
1978	3061.85	37752610.50	282.38	30313210.62	409190.00
1979	2980.43	38674059.68	266.96	30292485.12	423490.00
1980	2609.69	35627487.88	275.91	33256811.85	440520.00
1981	2493.48	26252705.72	278.51	35395557.39	569270.00
1982	2808.79	43053133.12	273.63	36212194.20	503480.00
1983	2657.10	41394960.90	281.43	38442493.71	492820.00
1984	2529.92	40149830.40	271.26	37982096.46	494840.00
1985	2485.66	39884900.36	262.58	37448634.44	472650.00
1986	2458.22	40091109.98	259.88	37578907.88	475540.00
1987	2367.96	39052396.32	261.55	38323090.65	506990.00
1988	2393.30	40348644.70	274.29	40820112.09	482980.00

	TIC	AVETEMP	DPOP	EMPE
1971		13.37	132.00	199.00
1972		12.09	128.00	193.00
1973	11767350.00	12.76	129.00	208.00
1974	9158000.00	12.16	138.00	233.00
1975	9261600.00	12.23	141.00	268.00
1976	9811570.00	14.07	140.00	278.00
1977	9842160.00	13.00	146.00	270.00
1978	9820560.00	13.12	147.00	290.00
1979	10587250.00	12.52	142.00	310.00
1980	13215600.00	13.37	148.00	332.00
1981	14231750.00	14.07	145.00	353.00
1982	12587000.00	12.45	168.00	340.00
1983	10842040.00	13.20	190.00	321.00
1984	10391640.00	13.02	197.00	329.00
1985	11343600.00	12.40	193.00	334.00
1986	10461880.00	12.82	195.00	337.00
1987	12167760.00	13.72	190.00	345.00
1988	12074500.00	13.77	185.00	356.00

	GDPA	IR	(1) NCC	(2) NDC	(3) NIC	(4) POPE
1971	26851.00	6.42		85027.00		496.00
1972	28844.00	6.00		86697.00		505.80
1973	32011.00	7.65	9824.00	88468.00	21.00	515.60
1974	34222.00	10.75	10189.00	90873.00	20.00	527.80
1975	35096.00	9.42	13121.00	93698.0	20.00	540.50
1976	36628.00	10.04	10994.00	97613.00	23.00	554.23
1977	38465.00	8.50	11559.00	101774.00	24.00	568.70
1978	40793.00	9.69	12330.00	107349.00	24.00	582.00
1979	45310.00	12.90	12976.00	113472.00	25.00	599.00
1980	47530.00	19.25	13652.00	120535.00	30.00	616.95
1981	50513.00	19.29	14539.00	127089.00	25.00	657.06
1982	48511.00	15.81	15328.00	132340.00	25.00	668.46
1983	47650.00	11.20	15579.00	136597.00	22.00	679.47
1984	50344.00	12.10	15870.00	140021.00	21.00	683.00
1985	53494.00	10.70	16046.00	142618.00	24.00	688.55
1986	54452.00	10.50	16309.00	144601.00	22.00	694.91
1987	57028.00	9.50	16492.00	146523.00	24.00	698.94
1988		9.50	16859.00	148821.00	25.00	705.90

	WRCC	WRDC	WRIC
1971	.0853	.1437	.06
1972	.0953	.1437	.06
1973	.1130	.1660	.08
1974	.1130	.1660	.08
1975	.1413	.1801	.11
1976	.1766	.2225	.13
1977	.2401	.3110	.16
1978	.2684	.3600	.18
1979	.2755	.3880	.18
1980	.2931	.4340	.19
1981	.3178	.4344	.21
1982	.3814	.5156	.26
1983	.4255	.5510	.29
1984	.4893	.6286	.34
1985	.5333	.6886	.37
1986	.5862	.7593	.41
1987	.6215	.8440	.44
1988	.6498	.8899	.46

APPENDIX B

FORECAST

APPENDIX B

WATER CONSUMPTION FORECAST

ID	ACCC :S	ACDC :S	ACIC :S	NCC :S	NCOMB :S
1988	2393.3	274.3	482980	16858.9	16884.5
1989	2185.3	274.5	491407	16744.8	16770.4
1990	2394.7	276.4	506427	16993.4	17019.1
1991	2415.9	277.3	519524	17317.1	17342.9
1992	2465.4	277.5	532619	17637.8	17663.6
1993	2467.0	277.4	540521	17983.8	18009.7
1994	2467.2	278.0	560464	18345.7	18371.7

ID	NDC :S	NIC :S	REV :S	REVC :S	REVD :S
1988	148821	25.5	6.82E7	2.621	3.632
1989	150299	25.6	6.63E7	2.377	3.672
1990	153553	25.6	7.02E7	2.644	3.777
1991	157123	25.7	7.21E7	2.718	3.876
1992	161482	25.8	7.44E7	2.825	3.987
1993	165637	25.8	7.16E7	2.882	4.088
1994	169346	25.9	7.81E7	2.951	4.189

ID	REVI :S	TC :S	TCC :S	TDC :S	TIC :S
1988	5.683E6	9.352E7	4.034E7	4.081E7	1.235E7
1989	5.794E6	9.045E7	3.659E7	4.126E7	1.259E7
1990	5.984E6	9.615E7	4.069E7	4.244E7	1.301E7
1991	6.150E6	9.877E7	4.183E7	4.356E7	1.337E7
1992	6.323E6	1.020E8	4.348E7	4.480E7	1.374E7
1993	6.436E6	1.043E8	4.436E7	4.594E7	1.399E7
1994	6.692E6	1.070E8	4.542E7	4.708E7	1.454E7

APPENDIX C

RATE IMPACT

APPENDIX C

RATE IMPACT ANALYSIS

ASSUMPTIONS

AVETEMP :A	DPOPR :A	EMPE :A	EMPER :A	GDPA :A
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879
13.7	0.0	356	0.0	59879

GDPALR :A	IR :A	POPEL :A	POPELR :A	WRCC :A
0.00000	10.8	698.9	0.0	.6498
0.00000	10.8	698.9	0.0	.7200
0.00000	10.8	698.9	0.0	.7500
0.00000	10.8	698.9	0.0	.7900
0.00000	10.8	698.9	0.0	.8300
0.00000	10.8	698.9	0.0	.8700
0.00000	10.8	698.9	0.0	.9100

WRDC :A	WRIC :A
.89	.46
.93	.48
.98	.51
1.03	.53
1.14	.56
1.19	.62
1.25	.65

ACCC :S	ACDC :S	ACIC :S	NCC :S	NCOMB :S
2295.28	275.863	507572	16616.9	16642.6
2172.69	274.347	504919	16616.9	16642.6
2120.31	272.453	500938	16616.9	16642.6
2050.45	270.559	498284	16616.9	16642.6
1980.60	266.392	494304	16616.9	16642.6
1910.75	264.497	486342	16616.9	16642.6
1840.90	262.224	482362	16616.9	16642.6

NDC :S	NIC :S	REV :S	REVC :S	REVD :S
148609	25.69	6.726E7	2.478	3.648E7
148609	25.69	7.013E7	2.599	3.791E7
148609	25.69	7.266E7	2.642	3.967E7
148609	25.69	7.511E7	2.691	4.141E7
148609	25.69	7.955E7	2.731	4.513E7
148609	25.69	8.214E7	2.762	4.677E7
148609	25.69	8.460E7	2.783	4.871E7

REVI :S	TC :S	TCC :S	TDC :S	TIC :S
5.998E6	9.217E7	3.814E7	4.099E7	1.304E7
6.226E6	8.984E7	3.610E7	4.077E7	1.297E7
6.563E6	8.859E7	3.523E7	4.048E7	1.286E7
6.784E6	8.708E7	3.407E7	4.020E7	1.280E7
7.111E6	8.519E7	3.291E7	3.958E7	1.269E7
7.746E6	8.355E7	3.175E7	3.930E7	1.249E7
8.055E6	8.195E7	3.059E7	3.896E7	1.239E7

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